

FORM PTO-1390  
(REV. 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371

GOW 0082 PA

U.S. APPLICATION NO. (If known, see 37 CFR 1.5

09/807485

INTERNATIONAL APPLICATION NO.

PCT/CA99/00928

INTERNATIONAL FILING DATE

13 October 1999

PRIORITY DATE CLAIMED

13 October 1998  
19 March 1999

TITLE OF INVENTION

HIGH CAPACITANCE ENERGY STORAGE DEVICE

APPLICANT(S) FOR DO/EO/US

Borisenko et al

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ has been communicated by the International Bureau.
  - c. ☒ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a. ☐ is attached hereto.
  - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
  - b. ☒ have been communicated by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **UNSIGNED**
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

**Items 11 to 20 below concern document(s) or information included:**

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information: **-Certificate of Express Mail Filing**

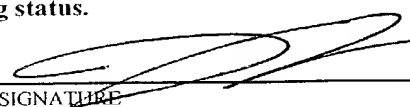
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| U.S. APPLICATION NO. (If known, see 37 CFR 1.53)<br><b>09/807485</b> | INTERNATIONAL APPLICATION NO.<br>PCT/CA99/00928 | ATTORNEY'S DOCKET NUMBER<br>GOW 0082 PA |
|--|---|---|

|  |              |              |              |                                  |        |  |
|--|--------------|--------------|--------------|----------------------------------|--------|--|
| 21. <input checked="" type="checkbox"/> The following fees are submitted:<br><b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):</b><br>Neither international preliminary examination fee (37 CFR 1.482)<br>nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO<br>and International Search Report not prepared by the EPO or JPO. .... <b>\$1000.00</b><br><br>International preliminary examination fee (37 CFR 1.482) not paid to<br>USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b><br><br>International preliminary examination fee (37 CFR 1.482) not paid to USPTO<br>but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b><br><br>International preliminary examination fee (37 CFR 1.482) paid to USPTO<br>but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b><br><br>International preliminary examination fee (37 CFR 1.482) paid to USPTO<br>and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b><br><br><b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b> |              |              |              | <b>CALCULATIONS PTO USE ONLY</b> |        |  |
|  |              |              |              | \$                               | 860.00 |  |
| Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30<br>months from the earliest claimed priority date (37 CFR 1.492(e)).   |              |              |              | \$                               | 130.00 |  |
| CLAIMS   | NUMBER FILED | NUMBER EXTRA | RATE         | \$                               |        |  |
| Total claims   | 16 - 20 =    | 0            | x \$18.00    | \$                               | 00     |  |
| Independent claims   | 2 - 3 =      | 0            | x \$80.00    | \$                               | 00     |  |
| MULTIPLE DEPENDENT CLAIM(S) (if applicable)  |              |              | 0 + \$270.00 | \$                               | 00     |  |
| <b>TOTAL OF ABOVE CALCULATIONS =</b>   |              |              |              | \$                               | 990.00 |  |
| <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above<br>are reduced by 1/2.  |              |              |              | \$                               | 00     |  |
| <b>SUBTOTAL =</b>  |              |              |              | \$                               | 990.00 |  |
| Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30<br>months from the earliest claimed priority date (37 CFR 1.492(f)).   |              |              |              | \$                               | 00     |  |
| <b>TOTAL NATIONAL FEE =</b>  |              |              |              | \$                               | 990.00 |  |
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be<br>accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property +   |              |              |              | \$                               | 00     |  |
| <b>TOTAL FEES ENCLOSED =</b>   |              |              |              | \$                               | 990.00 |  |
|  |              |              |              | Amount to be<br>refunded:        | \$     |  |
|  |              |              |              | charged:                         | \$     |  |

- a. ☐ A check in the amount of \$ \_\_\_\_\_ to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees.  
 A duplicate copy of this sheet is enclosed.
- c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any  
 overpayment to Deposit Account No. \_\_\_\_\_. A duplicate copy of this sheet is enclosed.
- d. ☒ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card  
 information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

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 NAME  
 39,564  
 REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of

Applicant : Borisenko et al  
Title : HIGH CAPACITANCE ENERGY STORAGE DEVICE  
Docket : GOW 0082 PA

BOX PCT  
Assistant Commissioner  
for Patents  
Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

Prior to examination of the above-identified patent application, please amend the application as follows:

IN THE CLAIMS

Please cancel claim 2.


REMARKS

This amendment is being made to place the claims in better form for examination.

Respectfully submitted,

KILLWORTH GOTTMAN HAGAN &  
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HIGH CAPACITANCE ENERGY STORAGE DEVICE**Field of the Invention**

The present invention relates to energy storage devices. In particular, the present invention relates to high capacitance energy storage devices, such as capacitors.

**Background of the Invention**

Relatively inexpensive and reusable electrical energy storage devices are clearly desirable. Prior art storage devices mainly consist of electrochemical cells. Typical electrochemical cells or batteries, such as iron-nickel and nickel-cadmium cells, have a number of well known disadvantages. Generally, the substances used to produce such cells are expensive and relatively scarce. These substances also tend to be non-recyclable, and potentially harmful to the environment, resulting in both costly production, reclamation and disposal. Electrochemical cells have a limited service life, ie. number of charge/discharge cycles, and shelf life, due to the irreversible reaction of either the electrolyte or electrodes in every charge/discharge cycle. In addition, their efficiency is relatively low, typically in the range of 15 - 50%, and depends on the operating conditions in which they are used, such as the ambient temperature.

Some advances have been made in the field of electrochemical batteries, such as the suppression of gas evolution by adding variable valency compounds to the electrolyte, and replacing environmentally harmful substances with metal hydrides. However, these advances add considerably to the cost of producing batteries and have not been widely adopted. Furthermore, the primary disadvantages of conventional batteries, their low efficiency, limited lifespan and degrading output, are not greatly improved by these changes.

Capacitors capable of storing large amounts of electrical energy, such as carbon double layer capacitors, are also known. Typically, these capacitors use carbonised materials to form polarized electrodes. Generally, the carbonised material is a paste formed from a carbon particle powder in combination with a binding agent. The carbon paste is spread over a metallic mesh which is packaged in a housing at high pressure to form the electrodes. While such capacitors have a theoretically high capacitance, the paste used exhibits non-Newtonian flow characteristics, and, therefore, under the high pressures required to achieve good electrical properties, the symmetric geometry of the electrodes necessary to produce high capacitance is compromised. Changes in the electrode geometry lead to variations in the electric characteristics

of separate cells, which fact leads to the destabilization of the capacitor in general and its eventual breakdown.

It is, therefore, desirable to provide a high capacitance energy storage device that obviates or mitigates at least one of the disadvantages of the prior art.

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### Summary of the Invention

A high capacitance energy storage device where electrodes are formed of layers of a carbonised, activated woven fabric that has been impregnated with an electrolyte. The electrolyte is absorbed by active centers at the surface of the carbonised, activated material. The prepared fabric is sandwiched between alternating graphite-based separators and non-conductive membranes to form a capacitor structure exhibiting very high capacitance, non-degradation over multiple charging/discharging cycles, and, in AC installations, reliable and reproducible characteristics. In addition, the materials in the device are environmentally friendly.

In an embodiment of the present invention, there is provided a high capacitance energy storage device. The device consist of a housing that is electrically isolated from, and lined with, conductive, chemically inert separators. The separators are, in turn, electrically connected to contacts mounted on the housing. At least one capacitive cell is contained within the housing. Each capacitive cell has a first electrode separated from a second electrode by a non-conductive, chemically inert membrane. The electrodes are formed of a carbonised and activated woven fabric impregnated with an electrolyte, the molecules of which can freely pass through the membrane. The cell is in electrical and mechanical contact with the separators.

In a further aspect, there is provided a capacitive cell for a high energy storage device. The cell consists of a first electrode separated from a second electrode by a non-conductive, chemically inert membrane. The electrodes are formed of a carbonised, activated woven fabric impregnated with an electrolyte. The chemically inert membrane permits free passage of molecules of said electrolyte therethrough.

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### Brief Description of the Drawings

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, in which:

30

Fig. 1 shows a cross section of a single layer cell of a high capacitance energy storage device according to the present invention;

Fig. 2 shows a cross section of a double layer cell of a high capacitance energy storage device according to the present invention;

Fig. 3 shows a cross section of a high capacitance energy storage device having a two double layer cells connected in series, according to the present invention; and

5 Fig. 4 shows a graphical representation of current density in relation to applied sandwiching pressure for a high capacitance energy storage device according to the present invention.

### Detailed Description

10 A first embodiment of a high capacitance energy storage device 10 according to the present invention is shown in Fig. 1. Device 10 consists of a housing 12 within which a single layer capacitive cell 14 is contained. In a preferred embodiment, housing 12 is a duralumin shell separated from cell 14 by current collectors 16, 18 which electrically isolate the housing 12 from the cell 14. Current collectors 16, 18, shown in Fig. 1 as separate elements, can  
15 form part of housing 12. If current collectors 16, 18 form the upper and lower surfaces of the housing 12, the side walls are chosen to electrically isolate them from each other. In this case, the side walls can be an appropriate dielectric material. The case is air tight and its internal surface is chemically isolated from an electrolyte used in the cell. Contacts (not shown) are provided on the exterior of the housing 12, as is well known to those of skill in the art.

20 Cell 14 consists of electrodes 20, 22 separated by a non-conductive, chemically inert membrane 24. The non-conductive, chemically inert membrane can be chosen from a wide selection of materials, provided they are transparent to the electrolyte particles. Suitable materials include: mipor, miplast, cellulose or paper-based sheets, and perforated polymer films, such as polyethylene, polystyrene and fluoroplast. The membrane 24 is transparent to the  
25 molecules of the electrolyte to permit the free passage of the molecules therethrough under the influence of an applied voltage. In a presently preferred embodiment, sulphuric acid in a water solution has been found to be a suitable electrolyte, but the present inventors contemplate that other electrolytes, as are known to those skilled in the art, can be employed. Generally, any electrolytic liquid, liquid mixture, sol/gel, etc. whose molecules initially have a non-uniform  
30 electron density, is applicable. It has been found that if the electrolyte is ionic, the effect of the charge redistribution at the time of charging device 10 is be more efficient.

Conductive, chemically inert separators 26, 28, that are barriers to the electrolyte molecules, are inserted between the housing 12 and the electrodes 20, 22 to chemically isolate

the cell 14 from housing 12. The separators 26, 28 can be formed from a variety of materials having a graphite base. Such chemically inert materials include: graphite plates and graphite foil (graphlex), conductive rubber and conductive polymer films..

Electrodes 20, 22 are made of a regularly structured organic substance, such as material woven from hydrocellulose. The hydrocellulose material is carbonised, and activated, or charged. Suitable woven materials are presently available for use as charged filters and, in the medical field, to cover wounds. Carbonisation is conducted for the purpose of producing chemically inert materials from the organic substance. Activation creates a porous structure with active centres. A method of producing such materials is described in Russian Federation Patent No. 2000360, dated January 22, 1992. In a currently preferred embodiment, the inventors of the present invention have successfully employed UVIS-AC cloth, manufactured by UVICOM, but other similar materials can be used as well. Generally, the carbonised, activated material should exhibit a specific surface area of 800 - 2000 m<sup>2</sup>/g, a total porosity of 0.25 - 0.80 cm<sup>3</sup>/g, and surface density of 100- 300 g/m<sup>2</sup>, and should contain little or no ash.

In a preferred embodiment, the electrodes 20, 22 are made of a woven fabric with a regular structure. The fabric is carbonised and activated, as described above. An electrolyte, such as sulphuric acid in solution, is impregnated onto the carbonised activated electrode fabric. The electrolyte can be any liquid, the molecules of which will have a non-uniform electron density when absorbed into the active centers on the carbonised, activated fabric, or when an electric field is applied. The impregnation of the electrolyte is a presently believed to be purely physical absorption, and a free volume of the electrolyte is absent once absorbed. The electrolyte is mainly absorbed on electrodes 20, 22 and non conductive inert transparent membrane 24. The electrolyte is a solution, mixture or a pure substance assisted by electrodes 20, 22 possessing active centres, in particular, carbonyl, carboxyl, hydroxyl and other groups. Generally, the impregnated electrodes 20, 22 exhibit characteristics of a solid body, as opposed to a non-Newtonian fluid as in the prior art.

The device 10 is assembled as describe above while ensuring that the electrode geometry is regular. The electrode geometry at the time of assembly is confirmed by ensuring a dependence between the received current density J relative to the pressure applied at the time of assembly, as shown in Fig. 4. As Fig. 4 shows, at pressures greater than 40 psi, further increase in pressure does not significantly alter the current density. In a preferred embodiment, device 10 is assembled at pressure of about 30 to about 80 psi. It has been found that this pressure range is sufficient to ensure reliable contact of all parts and elements contained in cell

14. In comparison with the high pressures required in prior art capacitors, this lower pressure of assembly can substantially simplify manufacture.

As will be apparent, the absorption of the electrolyte into the carbonised, activated woven fabric forms a generally solid, chemically indifferent electrode/electrolyte interface. At the very surface of the electrodes there is, in fact, a two phase, ie. solid/liquid surface. This has the advantage of dispensing with electrochemical reactions between the electrodes and electrolyte during charging and discharging, as is found in prior art high capacitance capacitors and batteries. It is believed that the absence of electrochemical reactions at the interface results from the low voltage at which device 10 can operate. The nominal operating voltage for device 10 is less than that which causes a reaction to occur. For example, if the disassociation voltage for water is 1.24 V, then device 10 is operated at a voltage below 1.24 V to prevent disassociation. Likewise, if the chosen electrolyte is sulfuric acid in a water solution (with a disassociation voltage of 1.67V) then device 10 is optimally operated at voltages below 1.67V.

The behaviours of the electrolyte particles near an electrode surface can be approximated by double layer capacitance theory. In double layer capacitors, a double layer is formed on the electrode surface by applying an electric field across the electrodes such that the electrolyte is absorbed by the electrode. Each electrolyte particle can be modelled as an elementary capacitor, with a capacitance, in Farads, of:

$$C = \frac{\epsilon_0 \epsilon S}{d}$$

where  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

$\epsilon =$  permittivity of free space  $\approx 1$  (assuming interparticle space between electrolyte ions to be a vacuum)

$S =$  electrode surface area ( $\text{m}^2$ )

$d =$  distance between an electrode surface and the center of an electron density of the electrolyte particle

Assuming the radius of an electrolyte particle to be in the order of  $0.3 \times 10^{-10} \text{ m}$ , the capacitance per unit area can be approximated as:



- 6 -

$$C' = \frac{C}{S} \approx \frac{\epsilon_0}{d} \approx 0.3 \text{ F/m}^2$$

Typically, an impregnated, woven fabric as described above has an electrode surface area in the range of 1000 m<sup>2</sup>/g, and as high as 2500 m<sup>2</sup>/g, resulting in energy storage devices having capacitances in the range of 300 - 750 F/g.

The energy stored by device 10 can be calculated by determining:

$$W = \frac{C U^2}{2}$$

where U = the voltage applied across the electrodes.

Fig. 2 shows a second embodiment of a high capacitance energy storage device 30, having a double layer capacitive cell 34, in accordance with the present invention. Similar elements are referenced by similar numerals in all Figures. Cell 34 consists of two electrodes 40, 42. Each electrode 40, 42 consists of two layers 44, 46 of the impregnated, woven material described above, thereby effectively doubling the capacitance, as will be well understood to those familiar with capacitor design, of the resulting device 30 in comparison to the embodiment of device 10.

Fig. 3 shows a third embodiment of a high capacitance energy storage device 50 having two cells 34 connected in series within housing 12. As will be well understood by those skilled in basic circuit theory, connecting the cells in series doubles the voltage that can be applied across device 50 as compared to device 30.

As an example of a high capacitance energy storage device according to the present invention, the inventors of the present invention have constructed a high capacitance energy storage device consisting of three 2 V units, each unit consisting of a pair of cells connected in series, as shown in Fig. 3. The device was built to resemble the standard case of a 6V chemical battery, IEC4R25. Each unit had dimensions 62x62x30 mm, giving a volume of 110 cm<sup>3</sup> and a mass of 105 gm. The electrodes of each cell were formed of 18 layers of the carbon impregnated woven material, such that each 2V unit consists of 72 layers of the carbonised activated material, and the total electrode volume was 43 cm<sup>3</sup> (44x44x22 mm) with a mass of 95 gm.

The device was charged over an extended period, until the charging current was less than 1mA. Once charged, each of the three capacitive cells exhibited a capacitance of 700

The resulting energy storage device is bipolar. In other words, if charged with one polarity it can be completely discharged and charged with the opposite polarity without risk of explosion or failure. In addition, short circuiting the device does not damage it.

It will be apparent to those skilled in the art that the foregoing is by way of example only. Modifications, variations and alterations may be made to the described embodiments without departing from the scope of the invention which is defined solely in the claims.

We claim:

1. A high capacitance energy storage device, comprising:  
a housing electrically isolated from, and lined with, conductive, chemically inert  
separators, said separators electrically connected to contacts mounted on said housing;  
5 at least one capacitive cell having a first electrode separated from a second  
electrode by a non-conductive, chemically inert membrane, said electrodes formed of a  
carbonised and activated woven fabric impregnated with an electrolyte, said cell being in  
electrical and mechanical contact with said separators;  
wherein said membrane permits free passage of molecules of said electrolyte  
10 therethrough.
2. A device according to claim 1, wherein said separators consist of a graphite-based  
material.
3. A device according to claim 2, wherein said separators consist of graphite sheets.
4. A device according to claim 2, wherein said separators consist of conductive  
15 rubber.
5. A device according to claim 2, wherein said separators consist of conductive  
polymer film.
6. A device according to claim 2, wherein said separators consist of graphite foil.
7. A device according to claim 1, wherein said electrolyte is a sulphuric acid  
20 solution.
8. A device according to claim 1, wherein said carbonised, activated woven fabric  
is formed from hydrocellulose.
9. A device according to claim 1, wherein each said electrodes is formed of a  
plurality of layers of said carbonised, activated woven fabric.
- 25 10. A device according to claim 1, wherein a single separator separates neighbouring  
cells.
11. A capacitive cell for a high energy storage device, comprising:  
a first electrode separated from a second electrode by a non-conductive,  
chemically inert membrane, said electrodes formed of a carbonised, activated woven fabric  
30 impregnated with an electrolyte, said chemically inert membrane permitting free passage of  
molecules of said electrolyte therethrough.
12. A device according to claim 11, wherein said electrolyte is a sulphuric acid  
solution.

13. A device according to claim 11, wherein said carbonised, activated woven fabric is formed from hydrocellulose.
14. A device according to claim 11, wherein each said electrodes is formed of a plurality of layers of said carbonised, activated woven fabric.

PCT

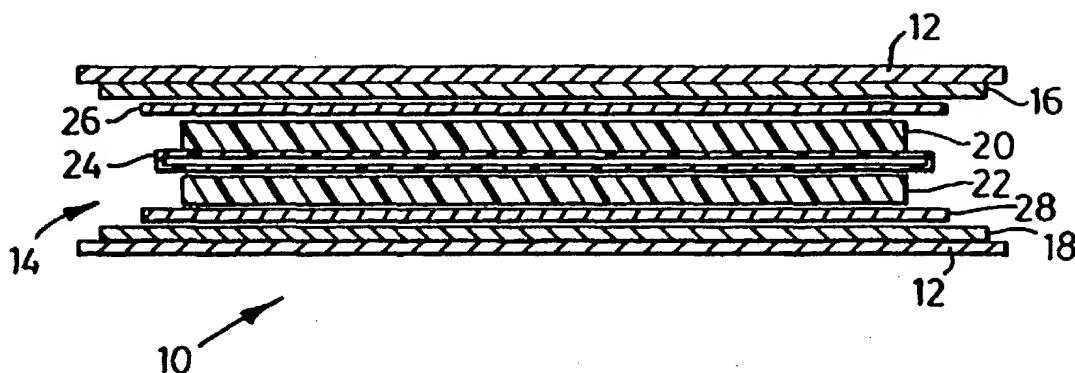
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International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <b>(51) International Patent Classification <sup>7</sup> :</b><br><b>H01G 9/155</b>  |  | <b>A1</b>   | <b>(11) International Publication Number:</b><br><b>WO 00/22637</b>     |
|  |  |   | <b>(43) International Publication Date:</b><br>20 April 2000 (20.04.00) |
| <b>(21) International Application Number:</b><br>PCT/CA99/00928  |  | <b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). |   |
| <b>(22) International Filing Date:</b><br>13 October 1999 (13.10.99)   |  |   |   |
| <b>(30) Priority Data:</b><br>2,250,628 13 October 1998 (13.10.98) CA<br>2,266,297 19 March 1999 (19.03.99) CA<br>2,266,185 19 March 1999 (19.03.99) CA  |  |   |   |
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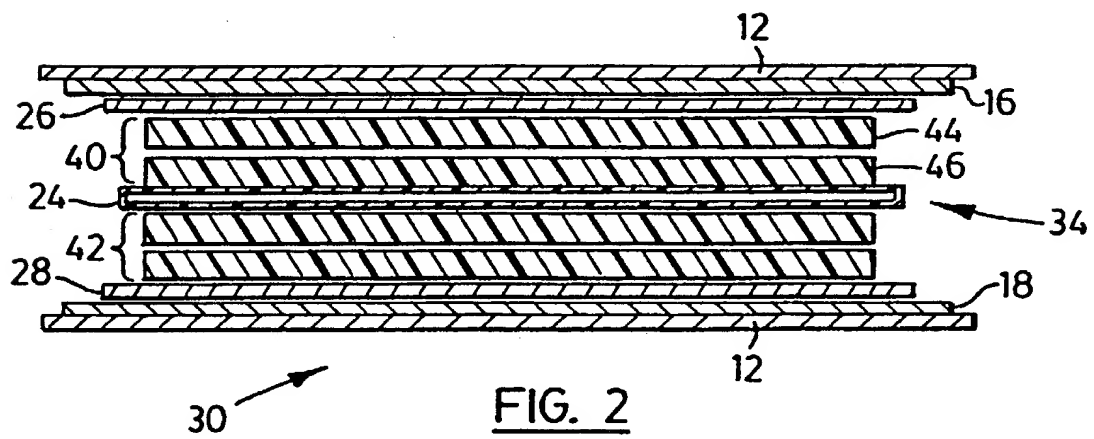
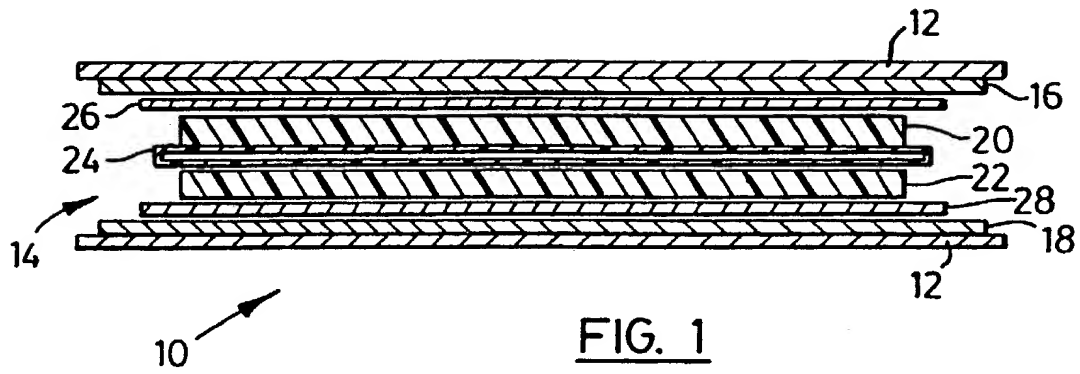
**(54) Title:** HIGH CAPACITANCE ENERGY STORAGE DEVICE



**(57) Abstract**

A high capacitance energy storage device where electrodes (20, 22) are formed of layers of a carbonised, activated woven fabric that has been impregnated with an electrolyte. The electrolyte is absorbed by active centers at the surface of the carbonised, activated material. The prepared fabric is sandwiched between alternating graphite-based separators (16, 18) and non-conductive membranes (24) to form a capacitor structure exhibiting very high capacitance, non-degradation over multiple charging/discharging cycles, and, in AC installations, reliable and reproducible characteristics. In addition, the materials in the device are environmentally friendly.

1/2



2/2

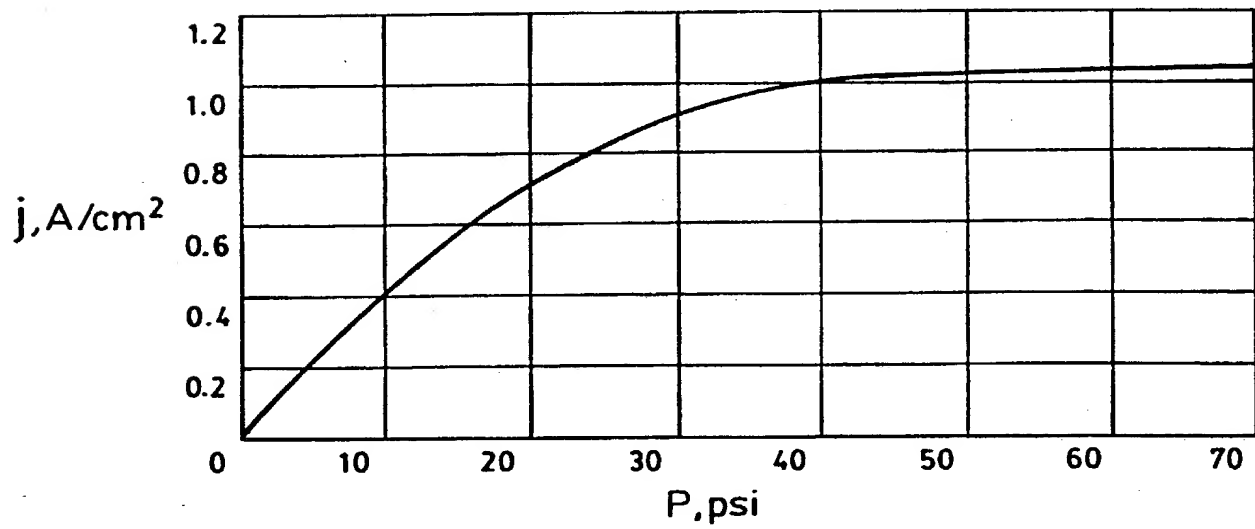
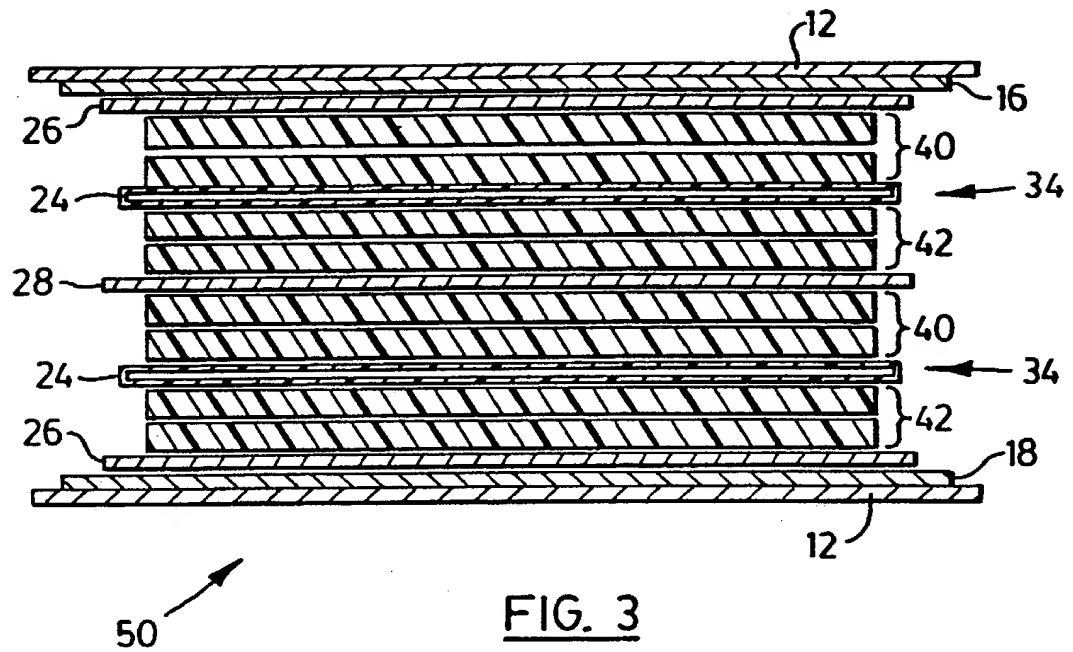


FIG. 4



DECLARATION AND POWER OF ATTORNEY  
(With Foreign Priority Claim)

As a below named inventor, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to our names; that we verily believe we are the original, first and joint inventors of the invention entitled:

HIGH CAPACITANCE ENERGY STORAGE DEVICE (Docket No. GOW 0082 PA),  
described and claimed

\_\_\_\_\_ in the attached specification;  
X in the specification filed April 12, 2001, as U.S. Application Serial  
No. 09/807485.

We hereby authorize the attorney(s) and/or agent(s) appointed herein to indicate above whether the invention is described and claimed in an attached specification and to provide the Filing Date and Serial No. of the corresponding U.S. Application, if previously filed.

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims as filed and as amended by any amendment referred to above.

We acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

We hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign applications(s) for patent or inventor's certificate listed below, as indicated. I/we have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed, and which is material to the examination of this application.

| Foreign Application(s)<br>Number | Country       | Day/Month/Year Filed | Priority          | Prior |
|----------------------------------|---------------|----------------------|-------------------|-------|
|                                  |               |                      | Claimed<br>Yes No |       |
| <u>2,250,628</u>                 | <u>Canada</u> | <u>10/13/1998</u>    | <u>X</u>          |       |
| <u>2,266,297</u>                 | <u>Canada</u> | <u>03/19/1999</u>    | <u>X</u>          |       |
| <u>2,266,185</u>                 | <u>Canada</u> | <u>03/19/1999</u>    | <u>X</u>          |       |

Full name of second Inventor: NIKOLAY BORISENKO

01 Inventor's signature: (deceased)

Date: May 16, 2002

Residence: Veyernaya Street  
5/1-152 Moscow  
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*RUX*

Citizenship: Russia

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CANADA

We hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

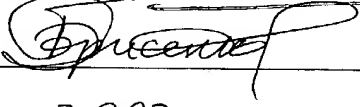
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|                      |                        |
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We further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full name of sole or first Inventor: DMITRY BORISENKO

Inventor's signature: 

200 Date: May 16, 2002

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